Sept. 15, 1942. F. L. CURRIE 2,295,636

METERING SYSTEM

Filed May 29, 1940 2 Sheets-Sheet 1

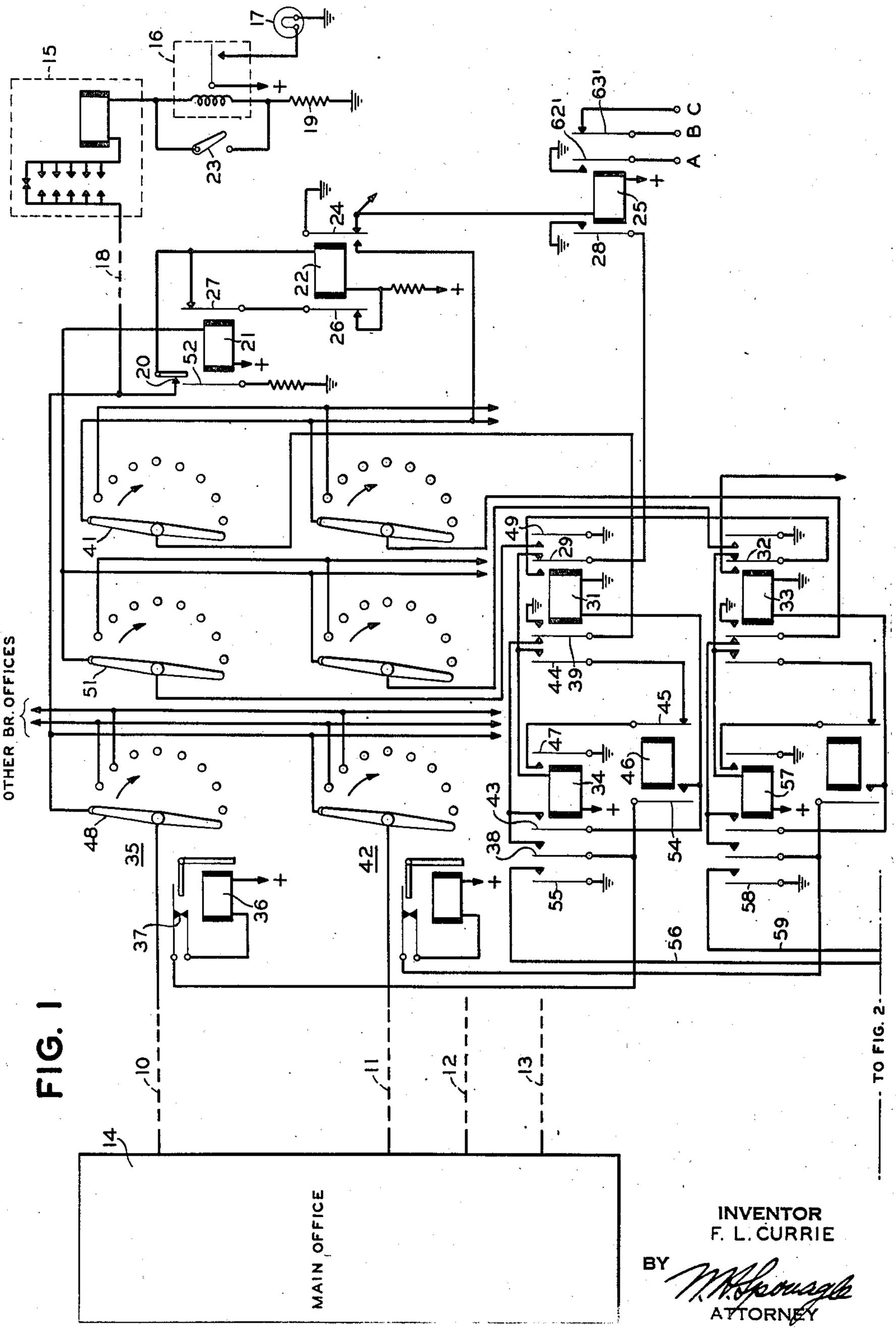

FIG. 1

INVENTOR
F. L. CURRIE
BY
ATTORNEY

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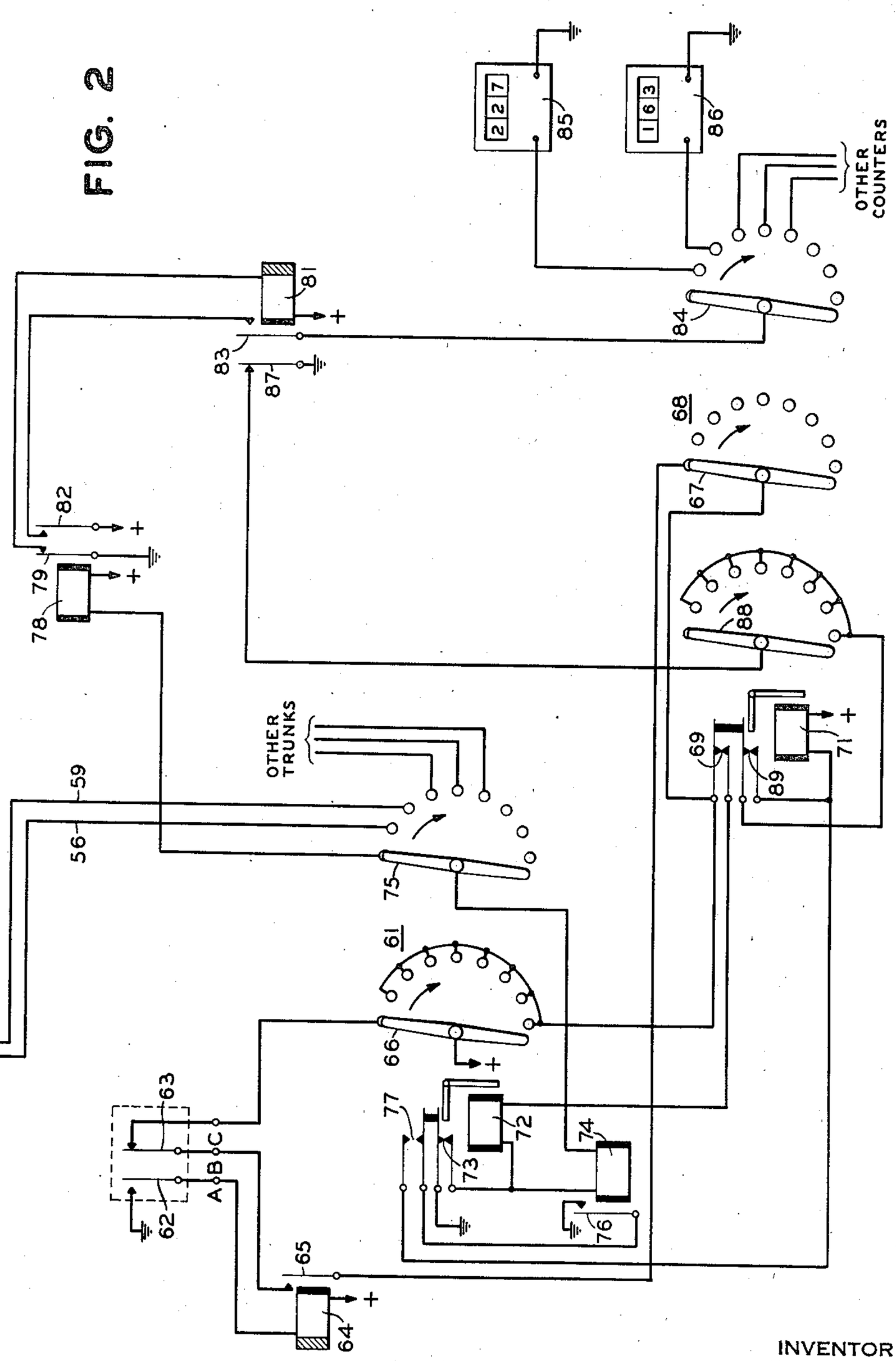
FIG. 2



INVENTOR
F. L. CURRIE

BY

ATTORNEY

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2,295,636

METERING SYSTEM

Frank Leslie Currie, Plainfield, N. J., assignor to The Western Union Telegraph Company, New York, N. Y., a corporation of New York

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9 Claims. (Cl. 178—2)

This invention relates to communication systems and has particular reference to a system for metering the load which is carried by trunking facilities extending from a central point.

Several telegraph systems have recently been placed in service wherein a relatively large number of branch offices or stations which are located in a small area remote from a central station are provided with switching facilities whereby connections may be made to any one of a relatively small number of trunks extending between a switching station and the central station. In these systems the switching station is generally located in one of the branch offices or at some other nearby point centrally located with respect to the group of branch offices. One system of this type is disclosed in detail and claimed in a copending appllication of W. B. Blanton, Serial No. 198,633, filed March 29, 1938, now Patent No. 2,227,121, granted December 31, 1940, and entitled "Printing telegraph system."

It is desirable, in a system of this character, to provide a sufficient number of trunks between the switching station and the central station to handle the normal maximum peak demand for trunking facilities to the central station. It is just as undesirable to provide more than the necessary number of trunks to handle the maximum simultaneous load. Consequently, it is necessary to have information regarding the load conditions placed upon the trunking facilities at various times, particularly at times of peak load.

The primary object of the invention is to provide novel metering facilities whereby a determination may be made of an unpredictable number of similarly conditioned instrumentalities, each of which may be represented by a predetermined electrical state.

Another object of the invention is to provide means for determining the maximum demand which is made upon the trunking facilities of a communication system.

Another object of the invention is to provide apparatus for counting the number of times that various numbers of communication trunks are being used simultaneously.

Another object of the invention is to provide means for registering the frequency of use which is made of all the trunks at the same time.

Another object of the invention is to provide means fcr intermittently counting the simultaneous use of the communication trunks.

Another object of the invention is to provide facilities for periodically determining the number of trunks which are in use at the time the determination is made.

Another object of the invention is to provide means operable immediately after one or more of the trunks is seized to count the number of trunks which are in use at that time.

The following description of an illustrative embodiment of the invention is taken in conjunction with the accompanying drawings, of which:

Fig. 1 is a schematic wiring diagram of some of the switching apparatus used to connect a branch office to one of a group of trunks extending to the central office; and

Fig. 2 is a schematic drawing of the metering apparatus used in conjunction with the switching equipment.

One type of switching apparatus with which the metering system comprising the instant invention may be used is described in detail in the aforementioned Blanton patent. Consequently, only enough of such a switching system is shown herein to describe the operation of the metering system which forms the subject matter of the instant invention. The apparatus shown in Fig. 1 may be located in one of a relatively large number of branch offices or in a switching station which is connected by means of a relatively small number of trunks 10, 11, 12 and 13 to a remote central office 14. The branch office equipment comprising a combination transmitting and receiving printing telegraph instrument 15, a polarized signal relay 16, and a visible signal 17 may be located in the station with the switching equipment or it may be located at some point in the vicinity and connected to the switching station by means of a line conductor 18.

By means of the switching apparatus the branch office printer 15 may be connected to any of the trunks extending to the central office 14 which is idle at the time a call is initiated from the branch office. During idle periods of the branch office equipment, the motor may be assumed to be running and the line circuit closed from the ground at the branch office through a resistance 19, the coil of the relay 16, the transmitting and receiving elements of the printer, the line conductor 18, contact 20 of relay 21, which is deenergized at this time, and the winding of relay 22 to positive battery. Because of this continuous circuit the branch office printer 15 is prevented from running idly and the relay 22 is energized, thereby operating its armatures to their respective front contacts.

When it is desired to initiate a call from the branch office, a switch 23 is closed short-circuit-

ing the winding of the relay 16, and the keyboard of the printer is operated once, preferably by depressing the word-space key, since this operation will cause nothing to be recorded by the printer. Any one of the non-selecting signals which are thus transmitted serves to open the line circuit, thereby releasing relay 22 and causing its armature 24 to apply a ground to its associated back contact and thereby energize relay 25. The engagement of armature 26 of relay 22 with its back contact serves to place a short circuit, which also includes armature 27 and back contact of relay 21, around the winding of relay 22. Therefore, once having released relay 22 by the momentary opening of the line circuit 18 it is not possible to re-operate this relay as long as relay 21 remains unoperated.

The energization of relay 25 effects the engagement of its armature 28 with its front contact thereby applying ground to a circuit which includes armature 29 of relay 31 and which is effective to start a sequence of switching operations, the purpose of which is to connect the calling branch office to an idle trunk, if one is available. There is provided one relay corresponding to relay 31 for each of the trunks. If the trunk associated with relay 31 is busy, the relay is in an operated state and the start circuit is connected through the front contact associated with armature 29 to armature 32 of relay 33 which is similar in its function to relay 31. The start circuit is extended through armatures and front contacts successively of the relays controlling these armatures which are associated with busy trunks until the relay which is associated with the first idle trunk is encountered. The start circuit is then transferred by way of the armature and back contact of this relay to initiate the switching functions which will result in the connection of the calling branch office to the lowest numbered idle trunk. If there are no idle trunks available, the ground which is applied to the start circuit is ineffective at this time to start the switching operations. However, as soon as one of the busy trunks becomes idle, the start circuit is connected in the manner described to perform its function.

Assume that, at the time the operator initiates a call by operating the keyboard of the printer 15 to release relay 22 and apply ground to the start circuit by the operation of relay 25, the trunk 10 is idle. The start circuit ground which is then applied to armature 29 of relay 31 is extended through the back contact associated with this armature to the winding of relay 34, thereby operating the armature of this relay. A circuit is then established for the operation of the finder switch 35 associated with the trunk 10. This circuit extends from battery, through the winding 36 and the interrupter contact 37 of the finder switch, through armature 38 and its front contact to a branched circuit. One of the branches of this circuit includes back contact and armature 39 of relay 31 and wiper 41 of the finder switch 35. The studs associated with the wiper 41 are connected in multiple to corresponding studs of the other finder switches such as the switch 42 and also are connected respectively to the front contacts of the relays associated with the branch offices, such as the front contact associated with the armature 24 of relay 22. When the associated branch offices are idle or in communication with the central office, these relays are energized, thereby connecting ground to the corresponding studs of the finder switches. However, the relay 22 associated with the calling branch office is released, thereby removing ground from the studs of the finder switches associated with this branch office. Consequently, the stepping circuit for the finder switch 35 is connected through the wiper 41 to the ground on all of the studs except the one associated with the calling substation. Therefore, the finder switch 35 is stepped successively over the grounded studs encountered by the wiper 41, the circuit being momentarily interrupted by means of the interrupter contacts 37, thereby performing the stepping operation in a well known manner. As soon as the wipers of the switch 35 become engaged with the studs associated with the calling branch office, the stepping circuit is opened at the stud associated with the wiper 41. In this case, relay 22 being released, the stepping circuit is opened when the wiper 41 engages the first stud as shown. The other branch circuit connected to the stepping magnet 36 includes the front contact and armature 43 of relay 34 and the winding of relay 31 to ground. It may be seen that as long as the wiper 41 is connected to grounded studs, the winding of relay 31 is short circuited. However, as soon as the wiper 41 steps onto an ungrounded stud, the winding of relay 31 becomes energized. The finder switch 35 does not continue to step under these conditions because the resistance of the winding of relay 31 is high enough so that insufficient current is furnished to the stepping magnet 36.

The energization of relay 31 effects the immediate engagement of armature 44 with its associated front contact before any of the other armatures of this relay are disengaged from their respective back contacts. The closure of this preliminary make contact provides a locking circuit for the relay 34. This circuit may be traced from battery connected to the relay through the winding, front contact and armature 44 of relay 31, back contact and armature 45 of relay 46 and through the front contact and armature 47 of relay 34 to ground. The establishment of this locking circuit immediately upon the energization of relay 31 is necessary since the subsequent movement of armature 29 of this relay from its back contact opens the operating circuit for relay 34. As soon as the armature 29 effects engagement with its front contact, the start circuit is transferred to the armature 32 of relay 33 so that any subsequent calls are routed to a higher numbered trunk. The operation of armature 39 of relay 31 from its back to its front contact interrupts the stepping circuit of the finder switch 35 at a second point and connects a ground through the wiper 41 to the stud upon which it is resting, thereby making corresponding studs on the other stepping switches busy so that they will not stop on these studs.

As shown herein, when the stepping switch 35 is stopped on the studs associated with the calling branch office, the trunk 10 is connected through wiper 48 and the first stud to the branch office line conductor 18, thereby extending the communication channel from the branch office to the central office. Such a connection is shown merely for the purpose of simplifying as much as possible this portion of the disclosure. For a preferred means of connecting the trunk circuit to the branch office circuit after the calling branch office has been located by the finder switch, ref-

erence is made to the aforementioned Blanton patent.

Armature 49 of relay 31 connects ground through its front contact and wiper 51 and the first stud associated therewith to operate relay 21. The operation of armature 52 of this relay disconnects the branch office line 18 from the positive battery associated with relay 22 and connects ground to the winding of relay 22. The disengagement of armature 27 of relay 21 from its back contact opens the short circuit around the winding of relay 22, thereby permitting this relay to operate. Relays 21 and 22 remain operated throughout the entire connection of the branch office with the central office. The operation of relay 22 places a ground from its armature 24 upon the studs of the finder switches associated with this branch office and opens the operating circuit for relay 25. The release of this relay removes the ground from the start circuit, thereby restoring it to normal as far as this particular substation is concerned. However, the operating circuit for relay 25 is multipled to all of the relays such as relay 22 associated with the other branch offices. By reason of this connection relay 25 is operated to close the start circuit and initiate an operation of one of the finder switches whenever one or more of the branch offices puts in a call. However, for the purpose of this description assume that the operation of relay 22 causes the release of relay 25.

As soon as the call is put through to the central office and a telegraph instrument connected to the trunk 10, the substation is so informed over the communication circuit thus established and may start transmission to the central office. At the completion of the communication, the switch 23 is opened so that if the system is arranged according to the teaching of the previously mentioned Blanton patent, the polarity of the potential applied to the substation apparatus may be reversed from positive to negative to close the contacts of relay 16 and operate the signal lamp 17. This may serve to notify the substation that is being called from the central office.

At the completion of the communication between the branch office and the central office, the operation of relay 46 is effected by means not shown herein but adequately disclosed in the Blanton patent previously referred to. The operation of this relay causes the engagement of its armature 54 with its associated front contact, thereby shunting armatures 38 and 43 and the respective front contacts of relay 34. The operating circuit for relay 31 is therefore maintained continuous. However, the disengagement of armature 45 of relay 46 from its back contact opens the locking circuit of relay 34, thereby releasing this relay. After this function has been performed, the relay 46 is released, thereby releasing relay 31 since its operating circuit is incomplete both through the contacts of relay 34 and the contact of relay 46. The release of this relay opens the operating circuit of relay 21 at the armature 49 of relay 31. The start circuit is also placed in communication with relay 34 so that the next call will operate this relay. The release of relay 21 again places the relay 22 under the control of the branch office and completes the restoration of this part of the system to normal.

Relay 34 has another armature 55 by means of which, when operated, ground is placed upon a conductor 56. Likewise, the relay 57 which corresponds to relay 34 and is associated with the trunk 11 is provided with a similar armature 58 which, when operated, places a ground upon conductor 59. These conductors and others from the apparatus associated with the other trunks are connected respectively to the studs of one level of a test switch 61. Whenever the switch 61 is stepped over its studs, each of the trunks is tested to determine whether or not it is busy. A busy condition is indicated by a ground appearing on the corresponding stud of the test switch 61 and each idle trunk is indiby the absence of ground from its corresponding stud on the test switch.

The test switch 61 is started by moving the armatures 62 and 63 first to the left and then to the right as shown in this drawing. The engagement of armature 62 with its left hand contact places a ground on the winding of relay 64, thereby causing this relay to operate its armature 65 to its front contact. As soon as the armatures 62 and 63 are returned to their right hand positions as shown in the drawing, the armature 65 of relay 64 does not immediately release because of a slow-to-release characteristic of this relay. At this time there is a circuit established from battery on the wiper 66 of the test switch 61 through the first or home stud associated therewith, the right hand contact and armature 63, the front contact and armature 65 of relay 64, the first or home stud associated with wiper 67 of a counting switch 68, through this wiper and the normally closed contact 69 associated with the stepping magnet 71 of the counting switch, the winding of the stepping magnet 72 of the test switch 61 and the interrupter contact 73 of this switch to ground. The stepping magnet 72 is thus energized and, upon the opening of the interrupter contact 73, the wipers of this switch are stepped to their respective second studs. Assume that the trunk control relay 34 is energized at this time because the trunk 10 is busy. A ground will then be connected through conductor 56 to the second contact of the test level. As soon as the wiper 66 of the test switch 61 engages the second contact in the stepping bank, the battery which is connected to the wiper is connected through the closed contact 69 of the counting switch 68 and through the winding of the stepping magnet 72. There is one path to ground from this point through the interrupter contacts 73, and another path through a low resistance relay 74 and the wiper 75 to the ground connected through the second stud of the test level and armature 55 of relay 34. At this time the stepping magnet 72 is energized and remains energized in series with the energized winding of relay 74 since the opening of the interrupter contact 73 is ineffective to cause the switch 61 to step because of the ground detected on the test stud. The energization of relay 74 causes the engagement of its armature 76 with its front contact thereby connecting ground through the contacts 77, which are now closed by reason of the fact that the stepping magnet 72 is still energized. The ground is further extended to the winding of the stepping magnet 71 of the counting switch 68. The energization of this stepping magnet opens the contact 69, thereby removing battery from the winding of the stepping magnet 72 of the test switch 61 and also from the winding of relay 74. The deenergization of the stepping magnet 72 permits the test switch to step to the next group of studs. The operating circuit for the stepping magnet 71 is opened at the contact 77 and also by the release

of relay 74. Consequently, the wipers of the counting switch 68 are advanced one step.

The test switch 61 steps uninterruptedly over its contacts as long as the wiper 75 does not become engaged with a stud to which a ground is connected. However, each time this wiper tests a trunk and finds it busy, the test switch 61 is caused to hesitate in its operation and the counting switch 68 is advanced one step.

When the wipers of the test switch 61 have completed a circuit of their associated contacts and have returned to the home studs as shown in the drawings, further operation is prevented because the operating circuit for the stepping magnet is interrupted at the contacts of relay 64 which were released shortly after the test switch stepped away from the home studs. The wipers of the counting switch 68, however, will be resting at this time on studs which correspond to the number of busy trunks which have been detected by the testing switch. The engagement of wiper 75 of the test switch 61 with its first or home stud completes a circuit which extends from battery through the winding of relay 78, the home stud and wiper 75, the winding of relay 74 and through the closed interrupter contact 73 to ground. The current which flows in this circuit is insufficient to operate the low resistance relay 74 but is sufficient to operate the relay 78. The disengagement of armature 79 of this relay from its back contact opens a circuit through the winding of relay 81 which has maintained this relay in an operated state during the sequence of operations just described. This relay has a slow-to-release characteristic which prevents the release of its armatures until a short time after the winding has been deenergized. Therefore, the engagement of armature 82 of relay 78 with its front contact closes a circuit from battery through the front contact and armature 83 of relay 81, through a wiper 84 of the counting switch 68, through whatever one of the studs associated with this wiper that is engaged by the wiper to operate one of a plurality of counters or registers such as the counters 85 and 86.

The relay 78 remains operated during the idle periods of the metering apparatus. However, soon after one of the counters has been operated, the armatures of relay 81 release. The disengagement of armature 83 from its front contact opens the operating circuit to the counter, and the engagement of armature 87 with its back contact applies ground to a wiper 88 of the counting switch 68. With the wipers of the counting switch 68 standing on studs other than the home studs, the ground connected to the wiper 88 is connected through the interrupter contact 89 and the winding of the stepping magnet 71 to battery, thereby providing a circuit for the operation of the counting switch so that it steps in rapid succession over the remainder of its studs until it reaches the first or home stud. It will be seen then that this auxiliary stepping circuit is incomplete, thereby preventing further operation of the switch.

As many counters are provided as there are trunks available. If, after a sequence of operation such as that described, the counting switch 68 is stepped to its second contact by reason of the fact that the tests have shown only one subchannel to be in operation, the counter 85 will be operated once. Similarly, when two trunks are found to be busy, the counter 86 will be operated once. The totals which are registered by the various counters are indicative of the number of trunks which were found to be in use at the time the test was made. These indications have no bearing on the identity of the particular trunks which happen to be in use. Consequently, at any time the counters may be inspected and, from the totals indicated thereby, it can be determined the number of times, for example, all of the trunks were in use. If it is found that all of the available trunks were in simultaneous operation an appreciable number of times, it would indicate that additional trunks might be necessary to handle the peak loads. Conversely, if it is found upon inspection of the counters that all of the trunks were never in simultaneous operation, it would indicate that a fewer number of trunks might provide adequate service.

The contacts 62 and 63 which are used to initiate a counting cycle may be controlled manually to secure a count at any time or by a clock mechanism which would make a count periodically or at any predetermined time, or they may be controlled by a relay whereby a count is made whenever a trunk is seized by a branch office. In the latter case these contacts might be controlled by the relay 25 such as by connecting points A, B and C of Fig. 2 to corresponding points of Fig. 1 as indicated. This relay is energized whenever a branch office puts in a call, thereby moving the armatures 62′ and 63′ to the left to operate relay 64 and maintain the stepping circuit for the test switch 61 open. As soon as the branch office line has been connected to a trunk, the relay 25 is released, thereby restoring the armatures 62′ and 63′ to their right hand positions and starting the stepping of the test switch 61 in the manner described.

It will be noted that relay 25 is under the control of all of the branch offices, so that if two or more branch office calls are put in at substantially the same time, the relay 25 is not released until all of the calls have been answered and trunks assigned to the calling branch offices. In this case, a count of the trunks in use is not made as each trunk is put in service, but any two or more which are seized during one operating cycle of the relay 25 are counted in the one operation of the metering equipment together with whatever other trunks are in use at the time.

The foregoing detailed description of a system embodying the invention is merely for the purpose of explaining the invention. The system shown and described may be modified in various ways without departing from the scope of the invention which is set forth in the appended claims.

What is claimed is:

1. In apparatus for making a determination of an unpredictable number of similarly conditioned instrumentalities, each of which may be represented by a predetermined electrical state, means to test sequentially for said electrical states, means for temporarily arresting said testing means upon the detection of one of said electrical states, means responsive to the arresting of said testing means to count the number of said electrical states detected, and means controlled by said counting means to disable said arresting means.

2. In a telegraph system, a plurality of line circuits, means for applying different load conditions to said system by simultaneously utilizing different numbers of said circuits, a register for each load condition, a step-by-step selector to select for operation one of said registers, a step-by-step tester for detecting each of the utilized

circuits, means to advance said selector one step for each busy circuit detected, and means to operate after the testing of all of said circuits the one of said registers selected.

3. In a telegraph system embodying a plurality of circuits of which a variable number may be simultaneously busy, metering apparatus for determining the number of simultaneously busy circuits comprising, a testing switch operable to explore the busy or idle condition of each of said circuits, means responsive to the detection of a busy circuit for temporarily locking said testing switch against further operation, a counting switch, means responsive to said locking operation for actuating said counting switch, and means controlled by said counting switch to disable said locking means.

4. In a communication system embodying a plurality of line circuits, means for simultaneously utilizing an unpredictable number of said lines, and metering apparatus for determining at intervals the number of busy lines, comprising a first stepping switch arranged to test in sequence the busy or idle condition of said lines, a second stepping switch employed to count the number of busy lines detected by said line-testing switch, each of said switches having auxiliary contacts, and means including said contacts for interlocking the operating circuits of said switches in a manner to cause in response to the detection of a busy line the momentary hesitation of said testing switch and the advance by one step of said counting switch.

5. In a communication system embodying a plurality of line circuits, means for simultaneously utilizing an unpredictable number of said lines, and metering apparatus for intermittently determining the number of busy lines, comprising a first stepping switch arranged to test in sequence the busy or idle condition of said lines, a second stepping switch employed to count the number of busy lines detected by said line-testing switch, each of said switches having auxiliary contacts, means for causing the uninterrupted step-by-step operation of said testing switch when idle lines are tested, means responsive to a busy line test to interrupt the operation of said testing switch, means including the contacts of said testing switch when operation is interrupted to cause a one step operation of said counting switch, and means including the contacts of said counting switch when operated to cause a resumption of the operation of said testing switch.

6. In a communication system embodying a plurality of line circuits, means for seizing an idle one of said lines, and metering apparatus operable upon the seizure of one of said idle lines for determining the number of busy lines, comprising a first stepping switch arranged to test in sequence the busy or idle condition of all of said lines, a second stepping switch employed to count the number of busy lines detected by said line-testing switch, each of said switches having self-interrupting operating circuits, said testing switch having normally open contacts included in the operating circuit of said counting switch, said counting switch having normally closed contacts included in the operating circuit of said testing switch, and means including said contacts for controlling the respective operating circuits of said switches in a manner to cause in response to the detection of a busy line the momentary hesitation of said testing switch and the advance by one step of said counting switch.

7. In a communication system embodying a plurality of trunk circuits of which an unpredictable number may be simultaneously busy, a mechanism for counting the number of busy trunks, comprising a testing switch having a bank of contacts, one for each trunk and each electrically conditioned according to the busy or idle state of its associated trunk, a wiper operable sequentially over said contacts, means including said wiper and one of said bank contacts associated with a busy trunk to arrest said testing switch wiper, an integrating device having a register, means responsive to the arresting of said wiper to operate said integrating device, and means operable after the completion of the testing of all of said trunks to actuate said register in accordance with the number of busy trunks detected.

8. In a communication system embodying a plurality of trunk circuits of which an unpredictable number may be simultaneously busy, a mechanism for counting the number of busy trunks, comprising a testing switch having a bank of contacts, one for each trunk, a wiper operable sequentially in a step-by-step manner over said contacts, a pulsating operating circuit for said testing switch including a stepping magnet, and a locking circuit for said testing switch including said stepping magnet, said wiper and one of said bank contacts associated with a busy trunk to interrupt the operation of said testing switch; a counting switch having a bank of contacts, a wiper operable sequentially in a step-by-step manner over said contacts, an operating circuit including a stepping magnet for said counting switch responsive to the interruption of the operation of said testing switch, and a contact operable upon the energization of said stepping magnet to open said locking circuit.

9. In a communication system embodying a plurality of trunk circuits of which an unpredictable number may be simultaneously busy, a mechanism for counting the number of busy trunks, comprising a testing switch having a bank of contacts, one contact for each trunk, a wiper operable sequentially in a step-by-step manner over said contacts, an operating circuit including a stepping magnet, a contact operable upon the energization of said stepping magnet to open said operating circuit, and a locking circuit including said wiper and one of said bank contacts associated with a busy trunk to maintain said stepping magnet energized; a counting switch having a bank of contacts, a wiper operable sequentially in a step-by-step manner over said contacts, an operating circuit including a stepping magnet, and a contact operable upon the energization of said stepping magnet to open said locking circuit; and a relay included in said locking circuit and operable to close the operating circuit of said counting switch upon the energization of said locking circuit.

FRANK LESLIE CURRIE.